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Quartermaster Corps
CLIMATIC RESEARCH LABORATORY
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Frank B. Rogers

1. Reports

The following reports have been sent to the Office of The Quartermaster General for the approval of Colonel Georges F. Doriot.

Report No. 64-A 14 January 1944

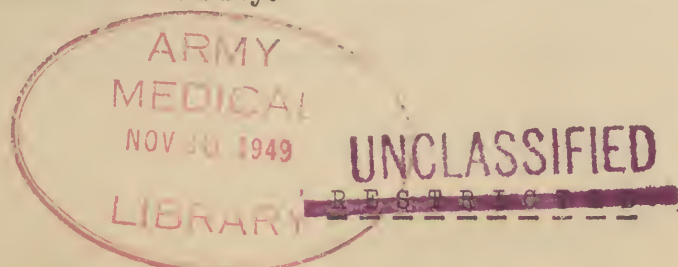
Mitten Combination

Thermal Insulation and General Utility at Rest and In Exercise
Eleven Tables and Nineteen Figures

Four grades or types of cold weather and Arctic, insert and shell, mitten combinations were tested in the cold room. Two were the standard combinations, M-1941 and M-1943 model, trigger finger, and two others were experimental items. The exposure temperature covered a range of 60°F., from minus 40°F. (-40°C.) to plus 20°F. (-6.7°C.). The greatest number of exposures was at minus 10°F. (-23.3°C.) and at minus 20°F. (-29°C.). These were followed by minus 40°F. (-40°C.), plus 20°F. (-6.7°C.) and minus 30°F. (-34.4°C.), respectively. Fourteen experimental subjects participated. Thermocouple harnesses were worn on the hands for measurement of skin (surface) temperature. Whenever possible, the subjects re-entered for a second exposure each half day. Clo de-terminations of a complete Arctic Assembly with different mitten combinations were also made.

The number of hours spent in the cold room was about equally divided between morning and afternoon experiments (160 and 150 hours), respectively. During the morning all subjects remained at complete rest until unbearably cold, while in the afternoon they were engaged in activity with the rifle to simulate sentry duty in the field.

Statistical analysis of the data at minus 10°F. and minus 20°F. was made. The results showed that both experimental combinations were superior to the standard ones in warmth, but were inferior in general utility for all-around use. Of the two experimental items, the Wilkins-Ford combination was the warmest, but the Washburn combination was somewhat better in its functional use. The M-1943 items proved to be a better combination than the M-1941 items both in regard to thermal insulation and utility.



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The M-1943 combination in rest has a mean tolerance time of 52 minutes at minus 40°F., 108 minutes at minus 10°F., and 167 minutes at plus 20°F. During light sentry duty the mean tolerance times are increased to 75, 124, and 180 plus, minutes, respectively. The M-1941 combination in rest has a mean tolerance time of 46 minutes at minus 40°F., 86 minutes at minus 10°F., and 154 minutes at plus 20°F. During light sentry duty the tolerance times are increased to 94, 106, and 180 plus, minutes, respectively. The tolerance times of the better experimental item (Wilkins-Ford) are from 40 to 100 percent longer than those of the colder standard item (M-1941).

A marked reduction in tolerance time during a second exposure in each half-day experiment was observed. The reduction in tolerance was as great as 50 percent. This is of great practical importance. Combat and non-combat soldiers in environments with low ambient temperatures should appreciate the relative inability of the human body to adequately restore body heat generally and heat to the hands locally without artificial means, once the hands have become unbearably cold.

Data from certain physical tests of thermal insulation are included. A hollow copper hand was used for the physical measurements. The standard mitten combinations only, were studied. The relative performance of the two combinations agreed with the physiological data, i.e., the M-1943 combination was slightly superior to the M-1941 combination.

A new scheme for grading subjective sensations was employed and the value of the schema confirmed.

Report No. 43-A 15 January 1944

Relationship of Permeability of Windbreak and Nature
of Underlying Fabric to Loss of Insulation Due to Wind
Two Tables and One Figure

Data have been compiled on the copper cylinder in the application of the methods described in Report No. 42. By the utilization of the data obtained it is possible to predict the amount of insulation lost at a wind velocity of 15 mph. for windbreaks of a wide range of air permeability and for 3 different kinds of underlying material.

As noted in Report No. 43, the physical characteristics of the fabric immediately beneath the windbreak is important. When herringbone twill with a permeability of from 10 to 12 cubic feet per square foot per minute is used as a windbreak, the loss of insulation is approximately a quarter of a clo with alpaca pile as the underlying fabric and an eighth of a clo or less when double pile, wool, is the base. When alpaca is used with the pile, directed inwards, there is no detectable loss in insulation. The need for caution in applying these findings to human clothing is stressed.

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Report No. 67 15 January 1944

Bag, Sleeping, Air Evacuation, Type I and II Design and Thermal Insulation

Five Tables and Three Figures

Two experimental sleeping bags, air evacuation (casualty) were tested in the cold room for comfort, suitable design and thermal insulation. The bags varied considerably in structure. They were rectangular in shape, large in size and had all-around zip-pers. Bag identified as Type I was planned by the designers as a double layered combination, inner and outer case was provided for testing. This bag as supplied weighed approximately 20 pounds. Bag identified as Type II was a single case and weighed approximately 27 pounds. It will be recalled that the standard, double case, arctic sleeping bag weighs 12 pounds. Both experimental bags were reported to contain the currently standard 40-60 mixture of feathers and down as filling material.

The exposure temperatures ranged from minus 10°F. to minus 40°F. It was concluded that Type II Bag (single layer) was superior to Type I bag (double layer bottom) in regard to thermal insulation, practical utility and rate of heat loss through the under surface of the bag. Each of the bags was less adequate than the standard double case arctic sleeping bag. If a comparison of thermal insulation with the standard arctic sleeping gear be made on a weight basis, the thermal insulation of the best casualty bag (Type II) is greatly inferior.

Report No. 58-B 18 January 1944

Tents, Mountain, Standard and Experimental
Moisture Distribution and Thermal Insulation
Seven Tables and Ten Figures

Five types of mountain tents, one the standard, two-man mountain tent, three, each, experimental tents of a design similar to that of the standard tent, and a fifth, a four-man double wall, experimental tent manufactured in Canada for the British Supply Mission were studied in the laboratory and the cold room. Two tents were of impermeable fabric, two of permeable fabric and the fifth was composed partly of permeable fabric and partly of impermeable fabric. The exposure temperatures varied from plus 75° to minus 50°F.

The distribution of moisture formed from 3 sources was determined. These were: (a) water of combustion from burning of gasoline in a stove; (b) from the evaporation of water in a pan on an electric hot plate, and (c) from the vapor of expired air and insensible perspiration of human subjects, respectively.

Four sources of heat were used in the measurement of thermal insulation. These were: (a) human subjects, (b) an electric hot plate; (c) a single burner gasoline stove and (d) a paraffine candle,

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respectively. The procedure for measuring thermal insulation included the temperature gradient between the inside and outside of the tent and clo values for humans.

No outstanding preference for any particular one of the two-man mountain tents was discovered from the studies of moisture distribution and thermal insulation. While each of the three two-man experimental tents has considerable merit, none of them was judged clearly superior to the standard tent in current use. It is believed by exclusion that the standard tent is an acceptable item.

There are advantages to an impermeable fabric for the walls of a tent and advantages in a permeable fabric. The lightest fabrics available for testing were impermeable. Such a combination is not inevitable, however, and light weight permeable fabrics should be available for tenting. The impermeable fabric does not allow for the escape of any appreciable amount of moisture neither does it permit snow and ice to collect in the interstices of the fabric with a resultant increase in the weight of the tent. It retains its original physical characteristics during continuous use. The permeable fabric that was tested, on the other hand, became relatively impermeable after several days of continuous use if it was not dried out periodically.

The advantages of a double wall over a single wall tent in thermal insulation was demonstrated in the four-man tent. The increase in temperature gradient between the interior of the tent and the outside was as great as 95 percent when the double wall was used instead of the single wall in comparable experiments. Furthermore, an obvious gain in thermal efficiency was noted when four men slept in a tent as opposed to two men.

It is concluded, on the basis of the experiments conducted, that the most effective tent for four men, taking into account protection, permeability, thermal insulation and utility in packing would be a single, pyramidal shaped, four-man, two wall tent with the inner wall of a moisture permeable, smooth fibered material and the outer wall of a durable sturdy windbreak material.

2. In the Daily Reports during the past month, tests on the following items were discussed:

Felt Shoe, Cold Climate,
Cold Climate Clothing
Mountain Boot, Ski, Bramani Sole
Bag, Sleeping, Wool
Underprotection for Sleeping Gear
Gloves
Field Trip

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